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E.S.L.

# TF 2102M

# A.F. Oscillator

INSTRUCTION MANUAL

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MARCONI INSTRUMENTS

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# INSTRUCTION MANUAL

No. EB 2102M

for

A. F. OSCILLATOR TF 2102M

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MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

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Chapter 1

# General information

## 1.1 INTRODUCTION

A. F. Oscillator type TF 2102M provides signals for audio frequency measurements in the range 3 Hz to 30 kHz. This frequency range is covered in four bands, and there is an uncalibrated fine frequency control. The instrument will provide an output level of +23 dBm (10 V) into a 600 Ω load, or 20 V e. m. f. The output is available at front panel terminals and is fed to these via a two-stage variable attenuator. The first stage provides switched 1 V steps and the second stage slightly more than 1 V level variation in the range of the first stage. Low power consumption is brought about by the use of transistors. The automatic level control circuitry has been designed to give no amplitude bounce.

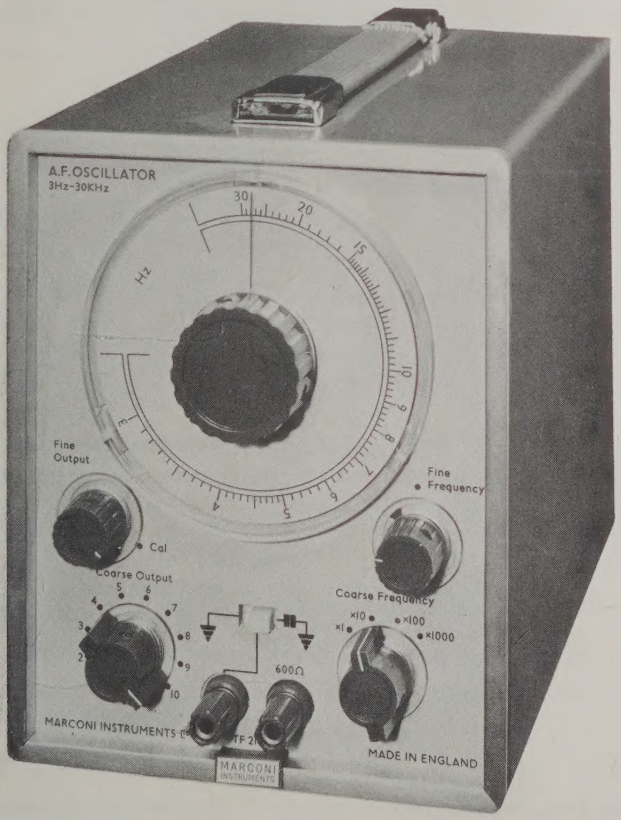



Fig. 1.1 A. F. Oscillator, TF 2102M

## 1.2 DATA SUMMARY

**Frequency**

| | |
|---|---|
| Range: | 3 Hz to 30 kHz in four decade bands. |
| Accuracy: | ±2%. |
| Stability: | Typically 0.02% per 15 minutes after 15 minutes warm up (assuming fairly constant ambient temperature). |

**Output**

| | |
|---|---|
| Impedance: | 600 Ω ±5% floating or unbalanced. |
| Level: | 0 to 10 V across 600 Ω (20 V e.m.f.) in 1 V steps, with fine control giving continuous cover between steps with nominally 5% overlap. |
| Frequency response: | Level remains constant typically within 1 dB over the full frequency range. |

**Distortion**

| | |
|---|---|
| Harmonic content: | Less than 1%. |
| Hum and noise: | Less than -80 dB relative to full output. |

| | |
|---|---|
| Power supply: | 105 to 130 V or 210 to 260 V, 45 to 500 Hz.<br>5 VA (45 mA to each 45 V supply line). |

Dimensions:

| Height | Width | Depth | Weight |
|---|---|---|---|
| 7 3/4 in (200 mm) | 5 3/4 in (150 mm) | 10 ½ in (270 mm) | 7 ½ lb (3.4 kg) |

## 1.3 ACCESSORIES

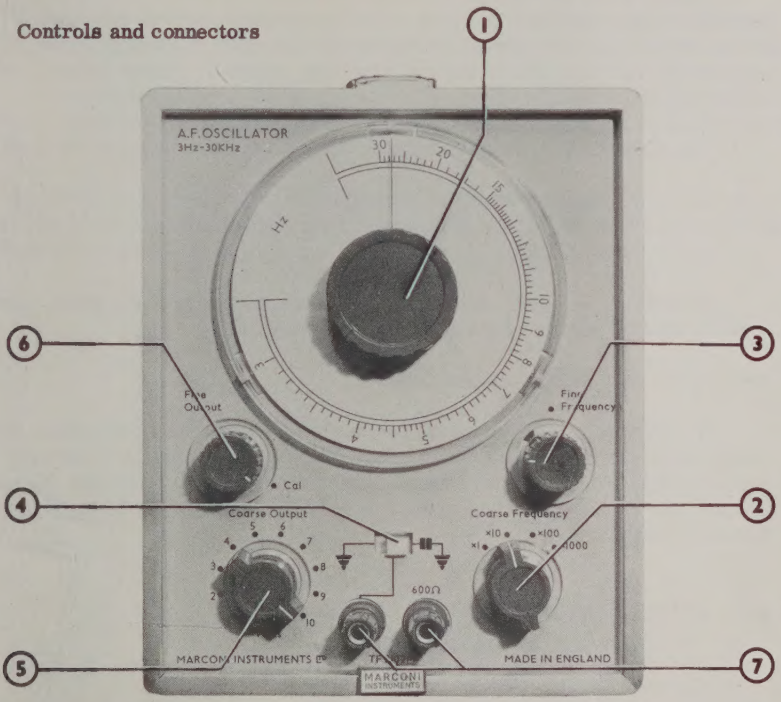
M. F. Monitored Attenuator type TF 2162 can be used with the TF 2102M1. A. F. Monitored Attenuator type TF 2160 or M. F. Monitored Attenuator type TF 2161 can also be used providing that the output power and frequency are kept within their capabilities.

Also available is a shielded adapter, type TB 39868 (Greenpar type GE 51002) which can be plugged into the output terminals of the oscillator to convert them effectively into a BNC coaxial socket.

Chapter 2

# Operation

## 2.1 Controls and connectors




① Frequency control and dial: use scale against the hairline at the top to set the required frequency.

② COARSE FREQUENCY: selects the frequency range.

③ FINE FREQUENCY: provides a fine tune control.

④ Coupling switch: determines whether the output signal is floating, with a capacitive impedance to earth, or earthed.

⑤ COARSE OUTPUT: this is calibrated in volts into a 600 Ω load.

⑥ FINE OUTPUT: this provides a variation of level of more than 1 V below the setting of the COARSE OUTPUT control.

⑦ Output terminals: 4 mm at 3/4 inch spacing.

Concealed in this view is the fuse which is mounted on the rear panel. This is rated at 250 mA for 200 to 250 V operation and 500 mA for 100 to 130 V.

## 2.2 PREPARING FOR USE

### POWER SUPPLY

Normally the instrument is dispatched ready for operation from a source having a voltage (including possible variation from the nominal value) in the range 200 to 260 V. For a source within the limits 105 to 130 V the tags on the mains transformer must be altered and the input fuse changed. These changes are described in greater detail in Sect. 4.4.

The mains lead is supplied without a plug; the colour code of the lead is:

| | | |
|---|---|---|
| Earth (ground) | : | green/yellow |
| Neutral | : | black |
| Line (phase) | : | blue |

In addition the earth wire carries a yellow sleeve bearing a green earth symbol, and the neutral wire has a sleeve marked 'N'.

### Precautions against high temperature

As it employs transistors the instrument is accordingly susceptible to abnormal temperature. Completely remove the plastic cover in which the instrument is normally supplied before attempting to use the instrument. Although the instrument is small and can be easily positioned, do not place it on top of, or close to, equipment that may overheat it.

## 2.3 SETTING FREQUENCY

To set the a.f. oscillator to a particular frequency:

(1) Set the COARSE FREQUENCY switch to the appropriate range.

(2) Turn the frequency control so that the dial indicates the required frequency against the hairline. The frequency is the product of the scale reading and the multiplication factor.

(3) Set the FINE FREQUENCY control to its calibrated position, which is in the centre of its travel, this is with the black dot on the front panel against the white line on the knob.

The FINE FREQUENCY control allows gradual and precise frequency adjustment over a limited range in the region of the setting of the main frequency controls. It can be used to minimize the frequency calibration error at a particular frequency, and in its vicinity by standardizing the calibration against a counter. The FINE FREQUENCY control also facilitates setting the instrument exactly to the optimum pass or rejection frequency of a highly selective circuit such as a filter having a narrow frequency response.

## 2.4 OUTPUT

Before connecting a sensitive load to the instrument, turn both the COARSE and FINE OUTPUT controls fully counter-clockwise to avoid applying too much signal.

Output from the a.f. oscillator is taken from the front panel terminals which contain sockets for 4 mm plugs and will accept a twin plug having 3/4 inch spacing.

The source impedance is 600 Ω floating or unbalanced and has a high degree of accuracy. In the floating state the value of capacitance to earth is of the order of 0.1 μF.

To obtain good shielding and facilitate employing coaxial leads the use of an adapter TB 39868 (an optional accessory) is recommended. This converts the output terminals into a BNC socket.

Chapter 3

# Technical description

## 3.1 GENERAL

This chapter should be read in conjunction with the circuit diagram , Fig. 7.1.

The circuitry may be divided into three basic parts; oscillator, amplifier and power supply.

## 3.2 OSCILLATOR

The oscillator is of the three-stage R-C phase shift oscillator type, using diode levelling control to avoid amplitude bounce.

A closed loop is formed by two frequency-dependent phase shift stages in cascade followed by a stage with an aperiodic phase change of 180 °. The frequency of oscillation is determined by the capacitance and resistance in the main path. The first stage is basically transistors VT1, VT2 and VT3 which provides a high input and low output impedance, and a gain of 20 times. This gain is defined by resistors R4 to R7. The phase shift components for this stage are RV1a, R1 and either C1, C2, C3 or C4 depending on the frequency range.

VT4, VT5 and VT6 form the second stage (identical configuration to the first). The gain defining resistors are R12 to R15. The phase shift components for this stage are RV1b, R9 and either C5, C6, C7 or C8 depending on the frequency range.

VT9 and VT10 provide a phase change of 180 ° with a gain of slightly less than unity, which is defined by R22 and the source impedance seen from the base of VT9.

The level control voltage is derived from a pair of limiting diodes fed from a point in the loop having the correct phase.

The limiting level for the silicon diodes MR1 and MR2 is set by the voltages across two forward biased germanium diodes. These diodes are the collector/base junctions of two transistors, VT7 and VT8, chosen for their low forward biased voltage drop. As VT7 and VT8 have a similar temperature coefficient to MR1 and MR2, the effects of variation in clipping level with temperature are minimized.

The base of VT9 is a virtual earth and the clipped waveform is arranged to be symmetrical about it by providing a 0.6 V stand off using MR3.

The output drive to the power amplifier is taken from the second stage via resistor R28 and the loop is completed by VT9 and VT10 .

For each frequency range one of RV3 to RV6 inclusive is in circuit and sets the alignment of that range.

## 3.3 ATTENUATOR AND AMPLIFIER

Between the oscillator and amplifier is the attenuating potentiometer R29 to R39 whose values have been selected to give 1V coarse steps in the output . The fine control , with voltage overlap, is obtained by tapping the attenuator at two points with SB. This gives , in conjunction with RV8 and R40, a swing of nominally 1.05V at the output terminals when the FINE FREQUENCY control is rotated through its range. The first two stages of amplification, VT11 and VT12, are two conventional common emitter stages .

VT13, VT14, VT15 and VT16 form a complementary stage. Because of the large voltage swings, about 56 V p-p, two pairs of transistors (VT13 and 14, VT15 and 16) are used in series in place of each of the normal two in a complementary symmetry stage .

The output impedance of the amplifier, at the junction of R51 and the emitter of VT15, is very low so that the output impedance is made 600 Ω by R56.

Diodes MR6, MR7 and MR8 are fitted to improve the temperature stability, C15 and R48 provide h.f. roll off for stability of the amplifier. RV9 and RV10 are set for minimum distortion; RV11 controls the output stage distortion.

## 3.4 POWER SUPPLY

Voltage lines of +40 and -40 are derived from the secondary voltage of the transformer, T1, by diodes MR9 - MR12 inclusive, centralized about 0 V by the transformer centre tap. VT17, VT18 and VT19 are emitter followers which smooth their respective voltage line. +10 V and -10 V stabilized lines are derived from the 40 V lines by the circuits R41/C10/MR4 and R42/C11/MR5. These lines are used to drive the oscillator section of the instrument.

# Chapter 4 Maintenance

NOTE: Performance limits quoted in this chapter are for guidance only and should not be taken as guaranteed performance specifications unless they are also quoted in the data summary.

## 4.1 CASE REMOVAL

To remove the instrument from its case, unscrew the screws in the four feet and slide the instrument out forwards.

## 4.2 COMPONENT LOCATION

The power supply circuitry and the frequency range capacitors are on printed circuit board TM 9532. The oscillator and amplifier circuitry are on printed circuit board TM 9533. The components used to select the output voltage are mounted on the wafers of the COARSE OUTPUT switch.

Printed circuit board TM 9532 is on the right-hand side of the instrument looking from the front panel; TM 9533 is on the left.

## 4.3 CIRCUIT VOLTAGES

These voltages, with respect to earth, were measured by a Marconi Instruments Differential D. C. Voltmeter type TF 2606. Readings for the oscillator board were taken with the COARSE and FINE OUTPUT controls at zero; those for the amplifier board were taken with these controls at maximum and with a 600 Ω external load.

| Point | Voltage (V) | Point | Voltage (V) |
|---|---|---|---|
| HT + line | +40.3 | VT4 b | +0.64 |
| HT - line | -45.8 | c | +3.77 |
| VT1 e | +0.156 | VT5 e | +4.38 |
| b | +0.63 | VT6 e | +0.49 |
| c | +4.07 | b | +1.10 |
| VT2 e | +4.68 | VT9 b | +0.61 |
| VT3 e | +0.71 | c | +4.67 |
| b | +1.36 | VT10 e | +0.71 |
| VT4 e | +0.16 | b | +1.02 |

| Point | | Voltage (V) | Point | | Voltage (V) |
|---|---|---|---|---|---|
| VT11 | e | +0.51 | VT16 | b | -24.5 |
| | b | 0 | VT17 | e | +40.3 |
| | c | -45.3 | | b | +40.9 |
| VT12 | e | -45.8 | | c | +46.1 |
| | c | +0.14 | VT18 | e | -46.7 |
| VT13 | e | +18.1 | | b | -47.1 |
| | b | +18.6 | | c | -46.9 |
| VT14 | e | +1.2 | VT19 | e | -45.8 |
| | b | +1.8 | MR1 | cathode | +0.64 |
| VT15 | e | +1.1 | MR2 | cathode | +0.41 |
| | b | +0.5 | MR3 | cathode | +0.64 |
| VT16 | e | -23.9 | RV7 | wiper | +0.65 |

Ripple

The following two voltages were measured on an oscilloscope.

| Line | Ripple (mV p-p) | Line | Ripple (mV p-p) |
|---|---|---|---|
| +40 V | 100 | -40 V | 150 |

Note: These are the components at the frequency that the oscillator has been set to.

## 4.4 MAINS TAPPING

To change mains tapping proceed as follows:

Having first disconnected the instrument from the mains supply remove the case as detailed in Sect. 4.1.

230 to 115 V (nominal) change

Disconnect the link A-B on the transformer (which is mounted on the rear panel of the transformer.

Connect A to the tag marked 120/240 and B to tag 0.

Change the fuse to one of 500 mA capacity.

115 to 230 V (nominal) change

Disconnect the wire links to tags A and B. Connect a link between tags A and B. Change the fuse to 250 mA rating.

## 4.5 SETTING UP PROCEDURE

Before setting up the instrument remove the case as detailed in Sect. 4.1. Sect. 4.2 describes the location of the printed circuit boards.

The following sub-sections cover the alignment of all the preset controls in the instrument. There is a certain amount of interaction between these controls so that if the controls mentioned in sub-sections 4.5.1, 4.5.2 or 4.5.3 are adjusted the suceeding section(s) should be followed.

Apparatus required:

a) valve voltmeter such as Marconi Instruments type TF 2600 series.

b) 600 Ω termination.

c) distortion factor meter such as Marconi Instruments type TF 2331.

d) high impedance d.c. voltmeter, e.g. Differential D.C. Voltmeter, Marconi Instruments type TF 2606.

e) counter such as Marconi Instruments TF 1417 series or TF 2414 series, or TF 2415 series.

### 4.5.1 Output level

Apparatus: a), b)

1) Connect the 600 Ω termination and valve voltmeter across the output terminals, turn RV10 (on TM 9533) fully clockwise and the frequency to the high end of the x10 range. Set the COARSE OUTPUT to 10 V and the FINE OUTPUT to CAL.

2) Adjust RV7 (on TM 9533) to give 10 V output.

3) Check the bottom three range outputs to be between 10 and 11.22 V (10 V +1 -0 dB). If necessary further adjust RV7 to meet this requirement.

4) Switch the COARSE FREQUENCY to x1000.

5) Adjust C9 (on TM 9533) for a flat frequency response and check that the output is between 10 and 11.22 V. (Occasionally further adjustment of RV7 is necessary to get the top range voltage correct; take care to ensure that the bottom three ranges remain within specification.)

4.5.2 Distortion

Apparatus: c)

1) Connect the distortion factor meter across the output terminals and adjust RV9 for minimum distortion. (Occasionally RV10 may also require adjustment from the fully clockwise position; if so the output level will require adjustment; sub-section 4.5.1).

4.5.3 Balancing the output stage

Apparatus: d)

To balance the push-pull output stage proceed as follows:

1) Connect the voltmeter across R51 and set both OUTPUT LEVEL controls to their minima (fully counter-clockwise).

2) Adjust RV11 so that 40 mV are developed across R51.

4.5.4 Frequency calibration

Apparatus: e)

1) Connect the counter to the output terminals. Set the COARSE FREQUENCY switch to x10 and the FREQUENCY control to 10 (frequency of 100 Hz).

2) Adjust RV4 to set the frequency to 100 Hz.

3) Switch to the other frequency ranges in turn (x1, x100, x1000) and adjust RV3, RV5 and RV6 respectively for frequency accuracy.

Chapter 5

# Replaceable parts

## Introduction

This chapter lists replaceable parts in alphabetical order of their circuit references. The following abbreviations and symbols are used:

| | | | |
|---|---|---|---|
| C | : capacitor | SKT | : socket |
| Carb | : carbon | T | : transformer |
| Cer | : ceramic | TP | : terminal |
| Elec | : electrolytic | V | : valve |
| FS | : fuse | Var | : variable or preset |
| ILP | : illumination lamp | WW | : wirewound |
| JK | : jack | W | : watts at 70 °C |
| M | : meter | W* | : watts at 55 °C |
| MR | : semiconductor diode | W** | : watts at 40 °C |
| PL | : plug | W*** | : watts at 20 °C |
| Plas | : plastic | W° | : watts at unspecified temperature |
| PLP | : pilot lamp | | |
| R | : resistor | | |
| S | : switch | | |

## Ordering

Orders for replacement parts should be sent to our Service Division at the address on the back cover of the Instruction Manual. Specify the following information for each part required:

1. Type and serial number of instrument.
2. Circuit reference.
3. Description.
4. M.I. code number.

If a part is not listed state its function, location and description when ordering.

| Circuit Ref. | Description | M.I. code |
|---|---|---|
| C1 | 3µF comprising 3X Plas 1µF 5% 125V | 26511-382 |
| C2 | 0.3µF comprising 3X Plas 0.1µF 5% 125V | 26511-349 |
| C3 | Plas 0.03µF 5% 750V | 26516-805 |
| C4 | Plas 3000pF 2% 125V | 26516-597 |
| C5 | 3µF comprising 3X Plas 1µF 5% 125V | 26511-382 |
| C6 | 0.3µF comprising 3X Plas 0.1µF 5% 125V | 26511-349 |
| C7 | Plas 0.03µF 5% 750V | 26516-805 |
| C8 | Plas 3000pF 2% 125V | 26516-597 |
| C9 | Var air 4-34 pF | 26812-314 |
| C10 | Paper 0.5µF 10% 150V | 26174-179 |
| C11 | Paper 0.5µF 10% 150V | 26174-179 |
| C12 | Elec 400µF +100-20% 6V | 26423-041 |
| C13 | Elec 400µF +100-20% 6V | 26423-041 |
| C14 | Elec 400µF +100-20% 6V | 26423-041 |
| C15 | Plas 330pF 5% 350V | 26516-373 |
| C16 | Elec 50µF +100-20% 35V | 26417-153 |
| C17 | Elec 1000µF +50-20% 25V | 26417-406 |
| C18 | Plas 0.1µF 10% 250V | 26582-208 |
| C19 | Elec 500µF +50-20% 50V | 26427-323 |
| C20 | Elec 500µF +50-20% 50V | 26427-323 |
| C21 | Elec 250µF +100-20% 70V | 26417-169 |
| C22 | Elec 250µF +100-20% 70V | 26417-169 |
| C23 | Cer 33pF 5% 750V | 26324-822 |
| C24 | Cer 33pF 5% 750V | 26324-822 |
| C25 | Cer 33pF 5% 750V | 26324-822 |

For symbols and abbreviations see introduction to this chapter

| Circuit Ref. | Description | M.I. code |
|---|---|---|
| FS1 | 250mA (250V supply) | 23411-055 |
| MR1 | 1S44 | 28357-548 |
| MR2 | 1S44 | 28357-548 |
| MR3 | 1S44 | 28357-548 |
| MR4 | ZB10 | 28371-846 |
| MR5 | ZB10 | 28371-846 |
| MR6 | AAZ12 | 28331-618 |
| MR7 | 1S44 | 28357-548 |
| MR8 | 1S44 | 28357-548 |
| MR9 | 1S923 | 28356-018 |
| MR10 | 1S923 | 28356-018 |
| MR11 | 1S923 | 28356-018 |
| MR12 | 1S923 | 28356-018 |
| R1 | Carb 1.3kΩ 1% $\frac{1}{4}$W | 24134-130 |
| R2 | Carb 100Ω 10% $\frac{1}{4}$W | 24342-050 |
| R3 | Carb 22kΩ 10% $\frac{1}{4}$W | 24342-118 |
| R4 | Met ox 330Ω 7% TE $\frac{3}{8}$W* | 24552-063 |
| R5 | Met ox 8.2kΩ 7% TE $\frac{3}{8}$W* | 24552-108 |
| R6 | Met ox 15kΩ 7% TE $\frac{3}{8}$W* | 24552-114 |
| R7 | Met ox 56kΩ 7% TE $\frac{3}{8}$W* | 24552-129 |
| R8 | Carb 3.9kΩ 10% $\frac{1}{4}$W | 24342-096 |
| R9 | Carb 1.3kΩ 1% $\frac{1}{4}$W | 24134-130 |
| R10 | Carb 100Ω 10% $\frac{1}{4}$W | 24342-043 |
| R11 | Carb 22kΩ 10% $\frac{1}{4}$W | 24342-118 |
| R12 | Met ox 330Ω 7% TE $\frac{3}{8}$W* | 24552-063 |
| R13 | Met ox 8.2kΩ 7% TE $\frac{3}{8}$W* | 24552-108 |
| R14 | Met ox 15kΩ 7% TE $\frac{3}{8}$W* | 24552-114 |
| R15 | Met ox 56kΩ 7% TE $\frac{3}{8}$W* | 24552-129 |
| R16 | Carb 3.9kΩ 10% $\frac{1}{4}$W | 24342-096 |
| R17 | Met ox 7.5kΩ 7% TE $\frac{3}{8}$W* | 24552-107 |

**For symbols and abbreviations see introduction to this chapter**

| Circuit Ref. | Description | M.I. code |
|---|---|---|
| R18 | Carb 6.8kΩ 10% ¼W | 24342-106 |
| R19 | Carb 8.2kΩ 10% ¼W | 24342-108 |
| R20 | Carb 15kΩ 1% ¼W | 24135-150 |
| R21 | Met ox 4.7kΩ 7% TE ⅜W* | 24552-100 |
| R22 | Carb 15kΩ 1% ¼W | 24135-150 |
| R23 | Met ox 22kΩ 7% TE ⅜W* | 24552-118 |
| R24 | Met ox 8.2kΩ 7% TE ⅜W* | 24552-108 |
| R25 | Met ox 15kΩ 7% TE ⅜W* | 24552-114 |
| R26 | Met ox 56kΩ 7% TE ⅜W* | 24552-129 |
| R27 | Carb 3.9kΩ 7% TE ⅜W* | 24342-096 |
| R28 | Met ox 680Ω 7% TE ⅜W* | 24552-076 |
| R29 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R30 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R31 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R32 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R33 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R34 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R35 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R36 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R37 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R38 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R39 | Met ox 430Ω 7% TE ⅜W* | 24552-067 |
| R40 | Met ox 43kΩ 7% TE ⅜W* | 24552-126 |
| R41 | Carb 1.8kΩ 10% ¾W* | 24343-086 |
| R42 | Carb 1.5kΩ 10% ¾W* | 24343-084 |
| R43 | Met ox 27kΩ 10% ¼W | 24552-120 |
| R44 | Carb 33kΩ 10% ¼W | 24342-122 |
| R45 | Met ox 150Ω 7% TE ⅜W* | 24552-054 |
| R46 | Carb 3.9kΩ 10% ¼W | 24342-096 |
| R47 | Carb 3.9kΩ 10% ¼W | 24342-096 |
| R48 | Met ox 560Ω 10% ¼W | 24552-072 |

For symbols and abbreviations see introduction to this chapter

| Circuit Ref. | Description | M.I. code |
|---|---|---|
| R49 | Carb 68Ω 10% ¼W | 24342-043 |
| R50 | Met ox 4.7kΩ 7% TE ⅜W* | 24552-100 |
| R51 | Carb 10Ω 10% ¼W | 24342-020 |
| R52 | Carb 2.2kΩ 10% ¼W | 24342-088 |
| R53 | Carb 1.8kΩ 10% ¼W | 24342-086 |
| R54 | Carb 2.2kΩ 10% ¼W | 24342-088 |
| R55 | Carb 1.8kΩ 10% ¼W | 24342-086 |
| R56 | Met film 600Ω 0.5% | 24634-801 |
| R57 | Carb 330Ω 10% ¼W | 24342-063 |
| R58 | Carb 27kΩ 10% ¼W | 24342-120 |
| R59 | Carb 27kΩ 10% ¼W | 24342-120 |
| R60 | Carb 330Ω 10% ¼W | 24342-063 |
| R61 | Carb 100Ω 10% ¼W | 24342-050 |
| R62 | Carb 33kΩ 10% ¼W | 24342-122 |
| R63 | Carb 560Ω 1% ¼W | 24133-560 |
| RV1a | WW 16kΩ 2% 4W° | 25874-579 |
| RV1b | WW 16kΩ 2% 4W° | |
| RV2 | WW 1kΩ 10% 1W° | 25815-110 |
| RV3 | Carb 2.2kΩ 20% ¼W | 25611-074 |
| RV4 | Carb 2.2kΩ 20% ¼W | 25611-074 |
| RV5 | Carb 2.2kΩ 20% ¼W | 25611-074 |
| RV6 | Carb 2.2kΩ 20% ¼W | 25611-074 |
| RV7 | Carb 22kΩ 20% ¼W | 25611-030 |
| RV8 | WW 1kΩ 10% 1W° | 25815-110 |
| RV9 | Carb 10kΩ 20% ¼W | 25611-025 |
| RV10 | Carb 1kΩ 20% ¼W | 25611-014 |
| RV11 | Carb 100Ω 20% ¼W | 25611-002 |
| | | |
| SA | COARSE FREQUENCY switch | TC31600/163 |
| SB | COARSE OUTPUT switch | TM 9673 |
| SC | FLOATING/EARTH 60 switch | 23467-119 |

For symbols and abbreviations see introduction to this chapter

| Circuit Ref. | Description | M.I. code |
|---|---|---|
| T1 | Mains transformer | TM 9718 |
| VT1 | BC108 | 28452-787 |
| VT2 | 2N3702 | 28433-488 |
| VT3 | BC108 | 28452-787 |
| VT4 | BC108 | 28452-787 |
| VT5 | 2N3702 | 28433-488 |
| VT6 | BC108 | 28452-787 |
| VT7 | 2N404 | 28423-508 |
| VT8 | 2N404 | 28423-508 |
| VT9 | BC108 | 28452-787 |
| VT10 | BC108 | 28452-787 |
| VT11 | 2N2904A | 54TM 9533 |
| VT12 | Special | 44552-018 |
| VT13 | 2N696 | 28455-805 |
| VT14 | 2N696 | 28455-805 |
| VT15 | OC203 | 28435-817 |
| VT16 | OC203 | 28435-817 |
| VT17 | 2N696 | 28455-805 |
| VT18 | 2N404 | 28423-508 |
| VT19 | OC203 | 28435-817 |

For symbols and abbreviations see introduction to this chapter

Chapter 6

# Circuit diagrams

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors: No suffix = ohms, k = kilohms, M = megohms
Capacitors: No suffix = microfarads, p = picofarads.

2. SWITCHES

Rotary switches are drawn schematically.

1F = 1st section, front
1B = 1st section, back
2F = 2nd section, front
etc.

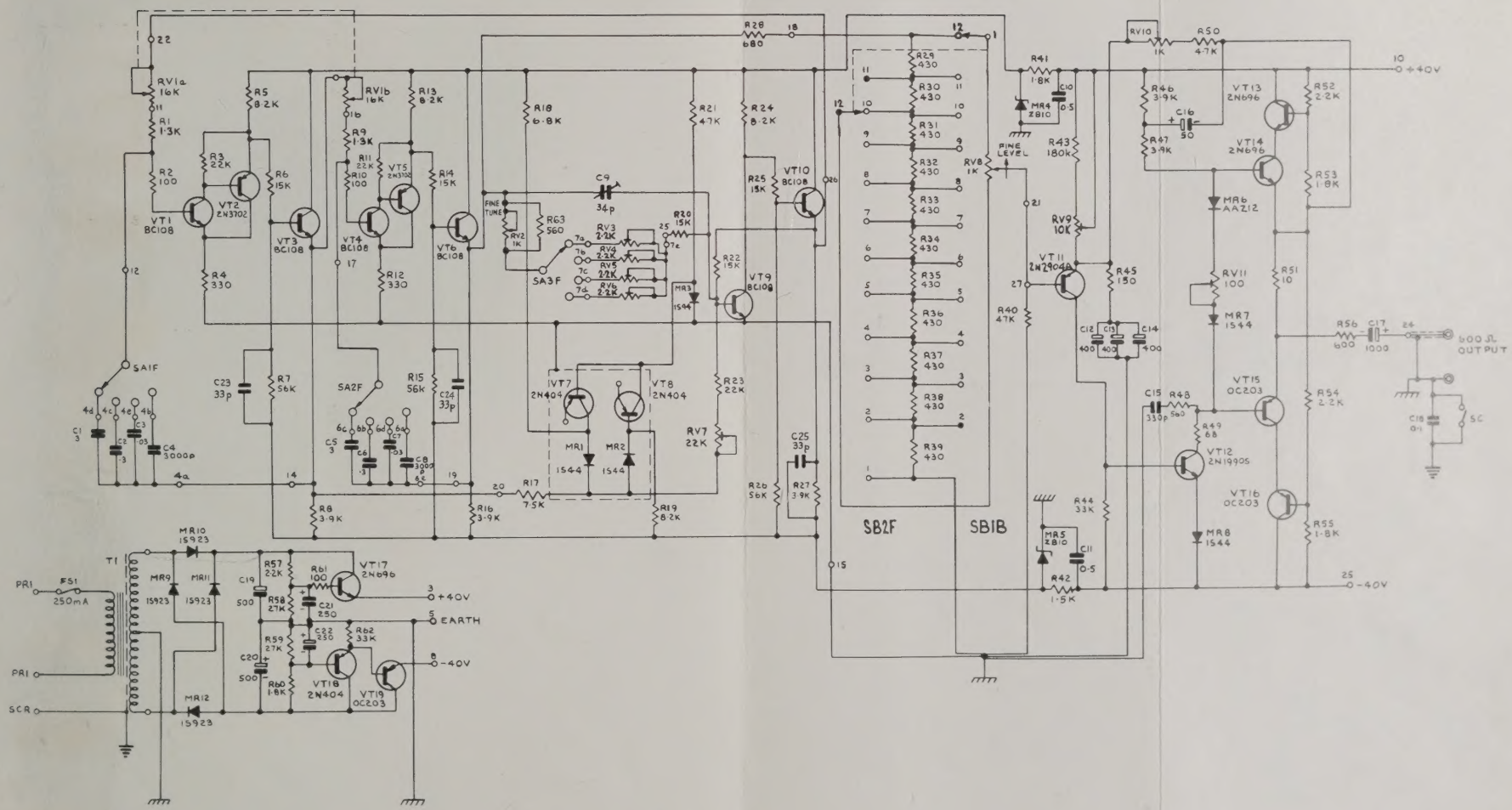



Fig. 6.1 Circuit diagram

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